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SUBJECT: A DESCRIPTION OF THE ISOTOPES DEVELOPMENT CENTER

#1794

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NOTICE

A DESCRIPTION OF THE ISOTOPES DEVELOPMENT CENTER

A. F. Rupp

September 30, 1963

In January 1962, the Atomic Energy Commission announced the establishment of the Isotopes Development Center at Oak Ridge National Laboratory.

The IDC was created primarily to coordinate the various isotope programs at Oak Ridge National Laboratory and more firmly establish Oak Ridge as a focal point for isotopes research, development, and information in the United States. The development of processes and the production of both stable and radioactive isotopes have been functions of Oak Ridge National Laboratory for almost twenty years. New programs on the comprehensive study of radioisotope characteristics and the establishment of an isotope information service provide basic isotope data and methods of disseminating such information to stimulate the uses of isotopes in the Nation's laboratories and factories.

The physical facilities of the IDC are scattered as much as ten miles apart in the Oak Ridge area. To illustrate the composition of the IDC as a whole, an artist's conception of the main parts (those administratively in the Laboratory's Isotopes Division) is shown in Fig. 1. Some isotopes development work is done in the general radiochemical engineering and analytical laboratories which are housed in other ORNL structures and are not shown on the sketch; the physical facilities in the Isotopes Division are the only ones devoted exclusively to isotopes research and development. Other general ORNL facilities extensively used by the IDC are the various reactors (ORR, LITR), shops, waste disposal plants, and general service areas. It is estimated that to duplicate the physical facilities devoted entirely, or in part, to IDC work would require an expenditure of more than $25,000,000.

The program of the IDC can be shown in a general but somewhat distorted way by examining the budget apportionments. The reason for the distortion is that a large amount of money is devoted to purchased raw materials in some programs, such as the radioisotope inventory accounts. The over-all operating budget of the IDC is about $10 million/year, not including equipment and capital projects. Referring to Fig. 2, we see that radioisotope research and technology is about one-quarter of the over-all IDC program. Research and development on stable isotopes and special targets (for accelerators) is considerably less, about 10%.

A further breakdown of the total IDC research and development program (about 35% of the total IDC budget as shown in Fig. 2) is shown on the chart in Fig. 3.

The major effort in radioisotope research and development is concerned with fission products. This includes methods of purification and forming the main long-lived fission products Cs^{137}, Sr^{90}, Ce^{144}, and Pm^{147} into many chemical compounds and physical forms. The chemical, physical, and radiation properties of these materials in the most pertinent chemical and physical forms are being investigated in detail. Process development work, primarily solvent extraction, for separating the fission products from waste streams is another major effort (9.8%) associated with the general fission product research and development program.

Some high-yield fission products have not been studied to the same extent as the four main fission products, but are nevertheless of great interest and potential: Ru^{106}, Zr^{95}-Nb^{95}, Kr^{85}, Tc^{99}, stable fission products (end products of decay chains), and many short-lived fission products. ORNL is the world's only source of separated, purified preparations of many of the less-common fission products.

Closely associated with fission product isotopic power development is the $Cm^{242-244}$ program to develop a concentrated heat source for devices for space missions. Fission products are already in use for heat generation in terrestrial applications, but are not yet being used for space missions. The curium research, development and production program involves a very advanced type of high radiation level radiochemical engineering.

Neutron products research is the traditional main-line radioisotope research effort at ORNL. The processes for most of the well-known radioisotopes were developed at ORNL--I^{131}, P^{32}, C^{14}, S^{35}, etc.--and a continuing effort has been made to improve these processes and the quality of the products obtained from them. For example, during the past 10 years the isotopic abundance of C^{14} has risen from 4% to almost 90%; P^{32} is separated routinely as very highly purified, carrier-free material, as is S^{35}; a new "vapor process" has been developed for processing fission product I^{131}. Scores of such processes have been developed and work is now directed at the newer isotopes, producing the better known radioisotopes more economically with higher specific activity and higher purity. Examples of recently developed methods are: fission-product Xe^{133}, I^{125} from neutron-irradiated Xe^{124}, Mn^{54} from Fe^{54}, Cu^{67} from Zn^{67}.

The ORNL 86-inch proton cyclotron has the largest beam current of any cyclotron in the world. It is a major factor in the production of neutron-deficient radioisotopes for the United States. A modest development program to develop new techniques and improve efficiency is carried on to extend our knowledge of cyclotron radioisotope production. Studies are being made on a larger and more versatile production-type cyclotron which may be constructed in the future to put more emphasis on this part of the radioisotope program.

It will be observed in Fig. 3 that the balance of the IDC research program is made up of one more large segment--stable isotope research and development--and a number of smaller projects. Stable isotope research is devoted almost exclusively to the improvement of the electromagnetic separations (calutron) processes for all the stable isotopes and U, Pu, and transplutonium elements. This includes work on improved ion sources, new magnetic field shapes, improved "isotope catchers," in-calutron target production, more sophisticated automatic controls for calutrons, and improved chemistry and analysis of the separated isotope products. A major capital project (estimated at $5-6 million) is being studied for a "hot calutron" laboratory to separate highly radioactive nuclides having alpha, beta, gamma, and neutron radiations.

Briefly, the smaller projects are as follows.

> Source Safety Testing - devoted to development of testing methods and specifications for radioactive sources to ensure safe usage.
>
> Advanced Technology - long-range planning covering the entire radioisotope field.
>
> Thermal Diffusion - methods for separating stable and radioactive isotopes of elements that are normally gaseous: argon, krypton, xenon, chlorine, etc.
>
> Analytical Radioisotope Projects - application of activation analysis techniques to forensic science (e.g., analyzing human hair) and industrial processes. Other analytical studies are characterizing radioisotopes by computer-gamma scanning, improving conventional analytical procedures by radiotracing techniques, and tagging with stable isotopes, followed by neutron activation and analysis.
>
> Radioisotope Instrumentation - improved methods of detecting and measuring radioisotope radiations, taking advantage of the most advanced transistors, solid state detectors, and other new electronic devices.

The development of radioisotope applications is not a part of the IDC program as a separate and distinct budget item at the present time. It is the policy of the AEC-DID to contract out specific applications development jobs to various organizations in the various fields of applications; e.g., the Bureau of Fisheries is working with Co^{60} sources on the radiation pasteurization of sea food; the use of radiotracers in studying food washing is being done by the National Canners Association; studies on coal by-products with radiotracers are being done by the Consolidation Coal Company. However, isotope applications work can be done by the IDC in several ways, as follows: (a) working out specific problems for those customers who are using radioisotopes purchased from ORNL; (b) collaborative work with AEC, NASA, DOD contractors, or private businesses, who have specific radioisotope problems that the IDC is uniquely qualified to solve; (c) submission of separate original isotope applications to AEC for funding as individual projects. The last mentioned method (c) has not been used thus far.

The IDC also functions as an isotopes information center. A small staff (three persons) is accumulating all published data on isotopes, and indexing this material so that it can be more readily used. While this group will primarily feed information into the ORNL-IDC and the AEC-DID Washington staff initially, it is intended to be of use to all groups in the United States who are working with isotopes. A technical progress review on isotopes will also be published quarterly; the first issue will be put out this fall.

Finally, the IDC lends assistance in special cases where training of personnel is needed in high radiation level chemistry and chemical engineering, radioisotope production and radioisotope handling. Thus far, training has been limited to co-op students and trainees especially designated by the AEC, including participants from foreign countries. Some widening in scope of this activity is expected, possibly to include graduate students.

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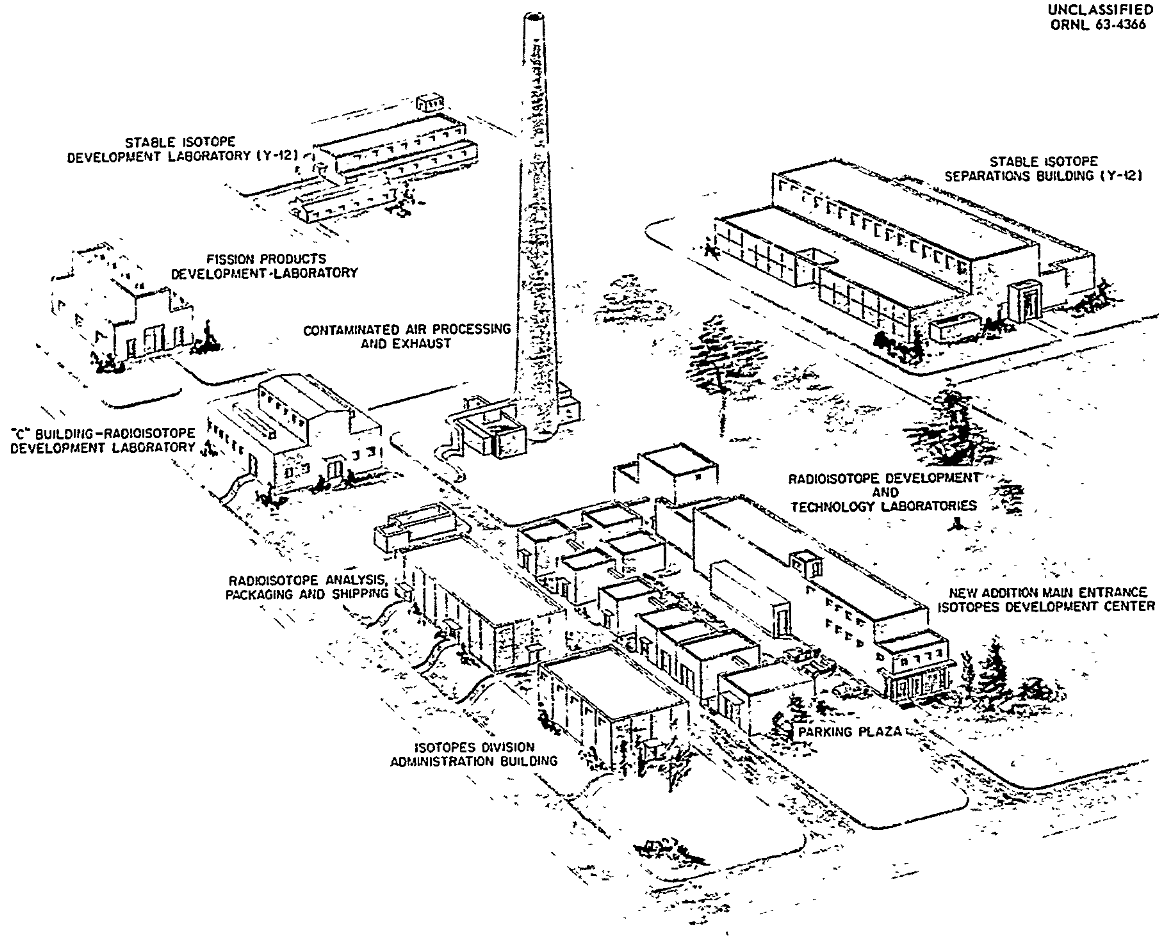

Fig. 1. The Isotopes Development Center.

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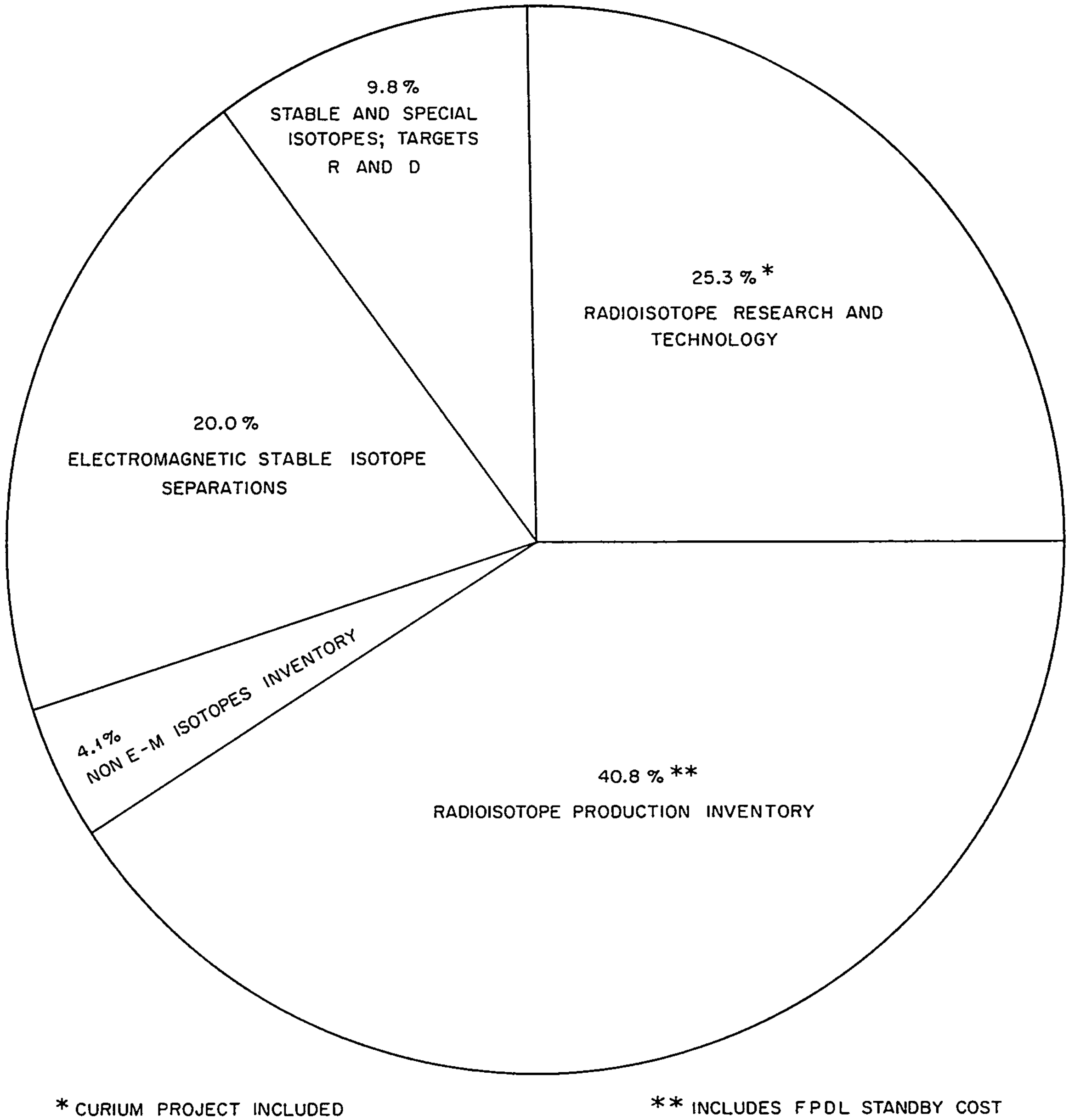

Fig. 2. Isotopes Development Center Budget; Major Categories.

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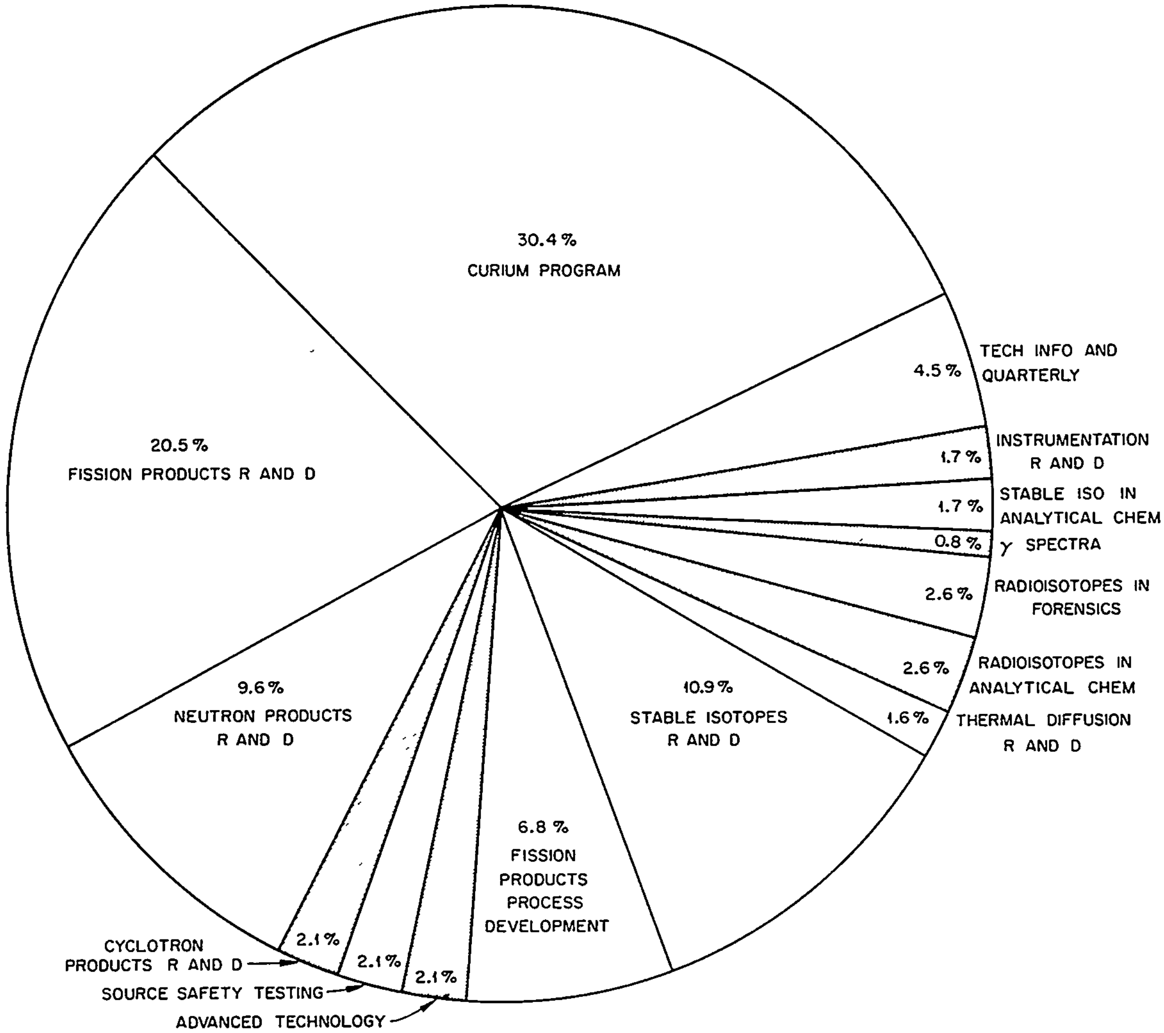

Fig. 3. Isotopes Development Center; Research and Development Budget.

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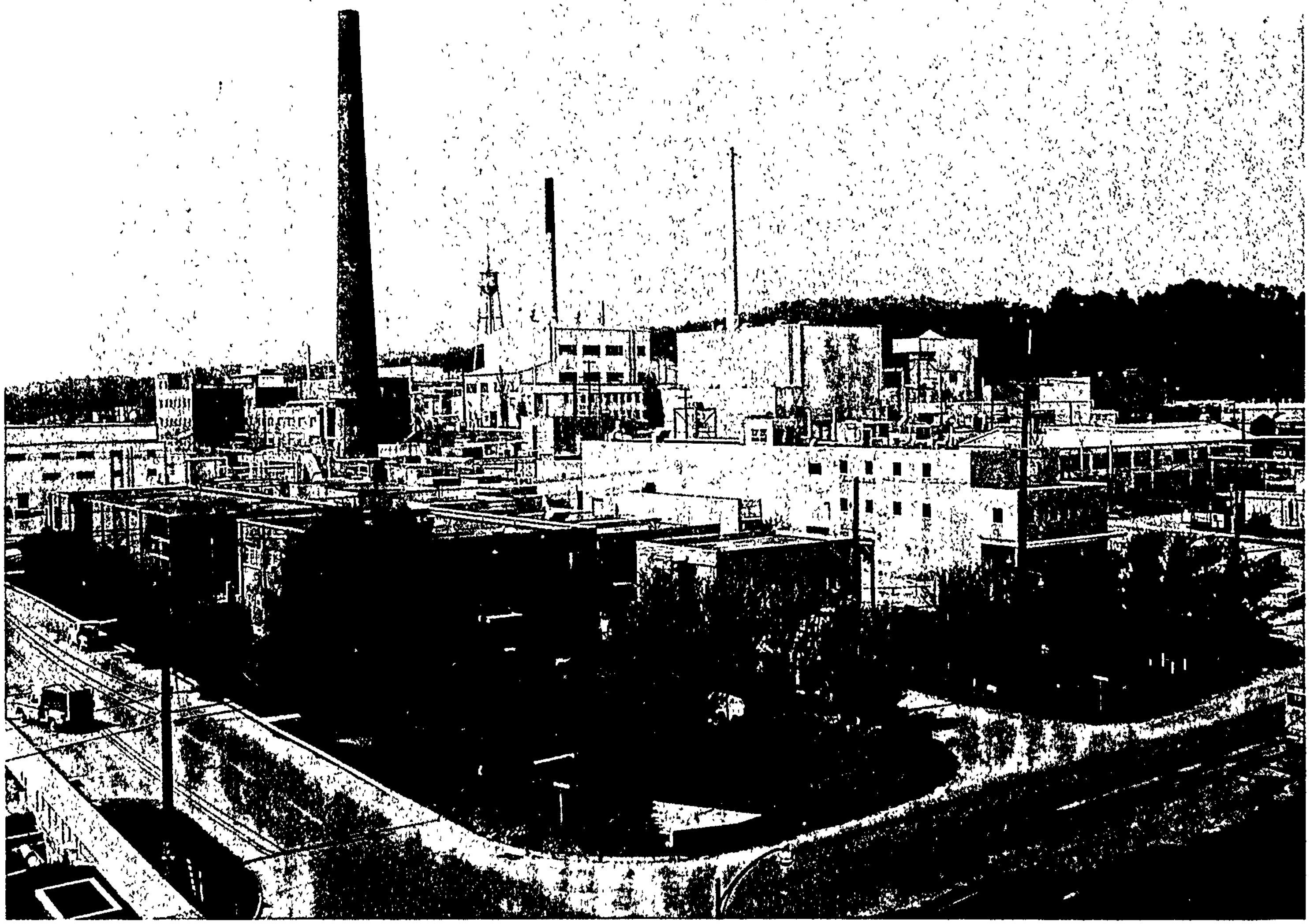

Fig. 4. Isotopes Development Center, X-10 Site. Headquarters and Radioisotope Production and Development Area. New development building at rear still under construction.

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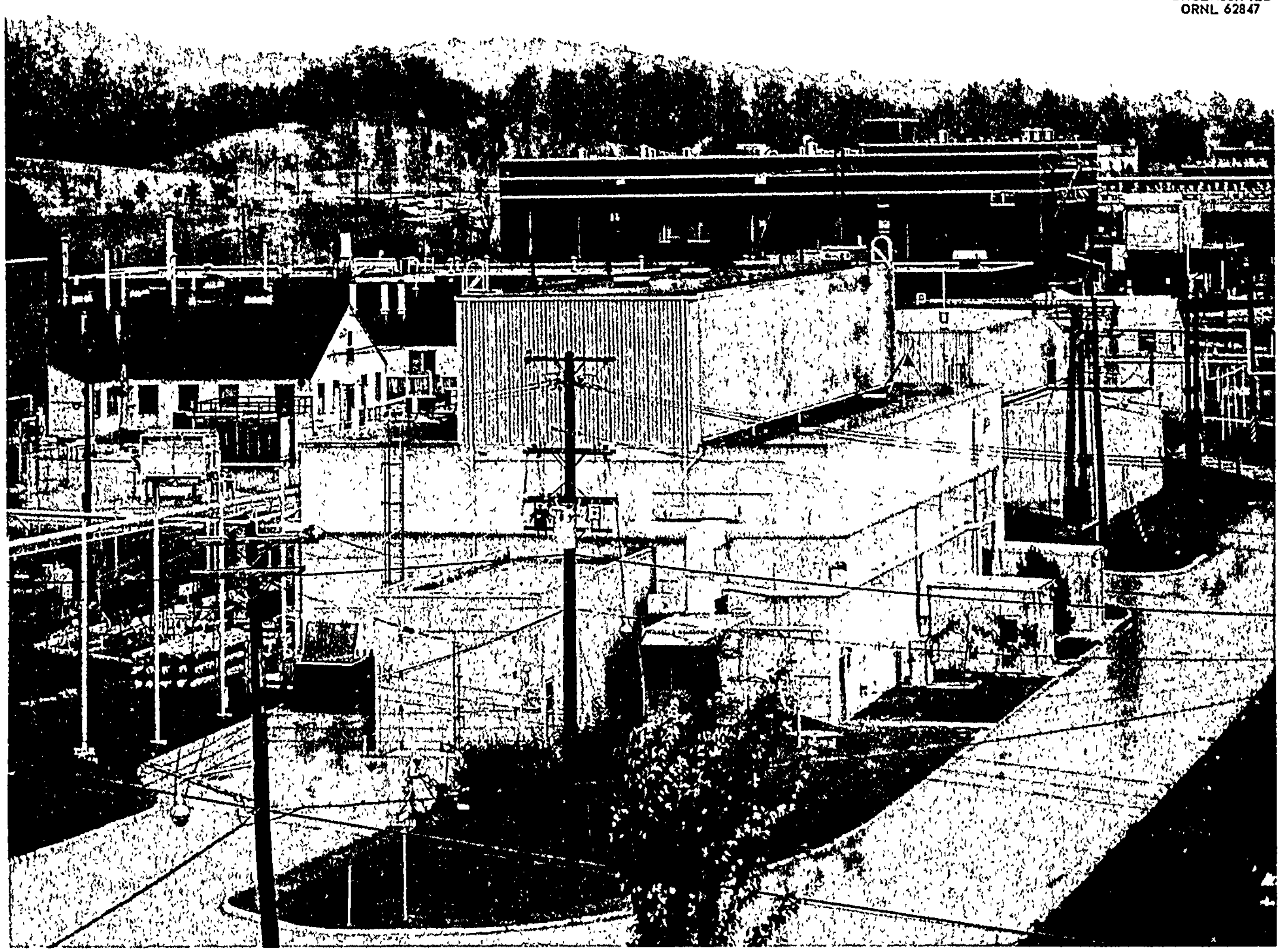

Fig. 5. Fission Product Development Laboratory (FPDL). Exterior view, looking NE. This building is completely contained and is kept at a negative pressure of 0.3" H_2O. Truck airlock in foreground. Personnel and small equipment airlocks on south side.

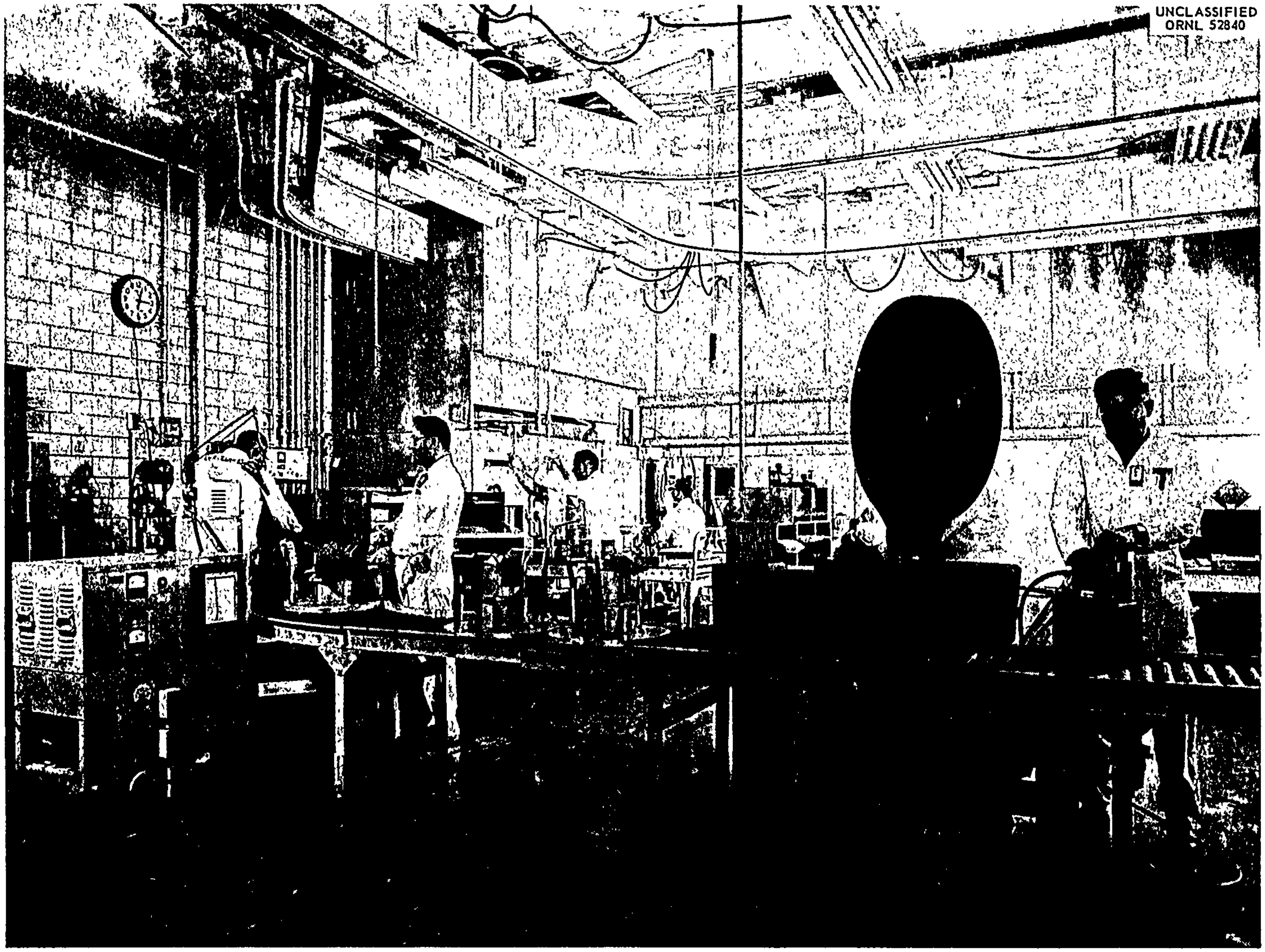

Fig. 6. Radioisotope Packaging Area. Radioisotopes are packaged in an assembly line process; initial operations are done by remote control behind heavy shielding.

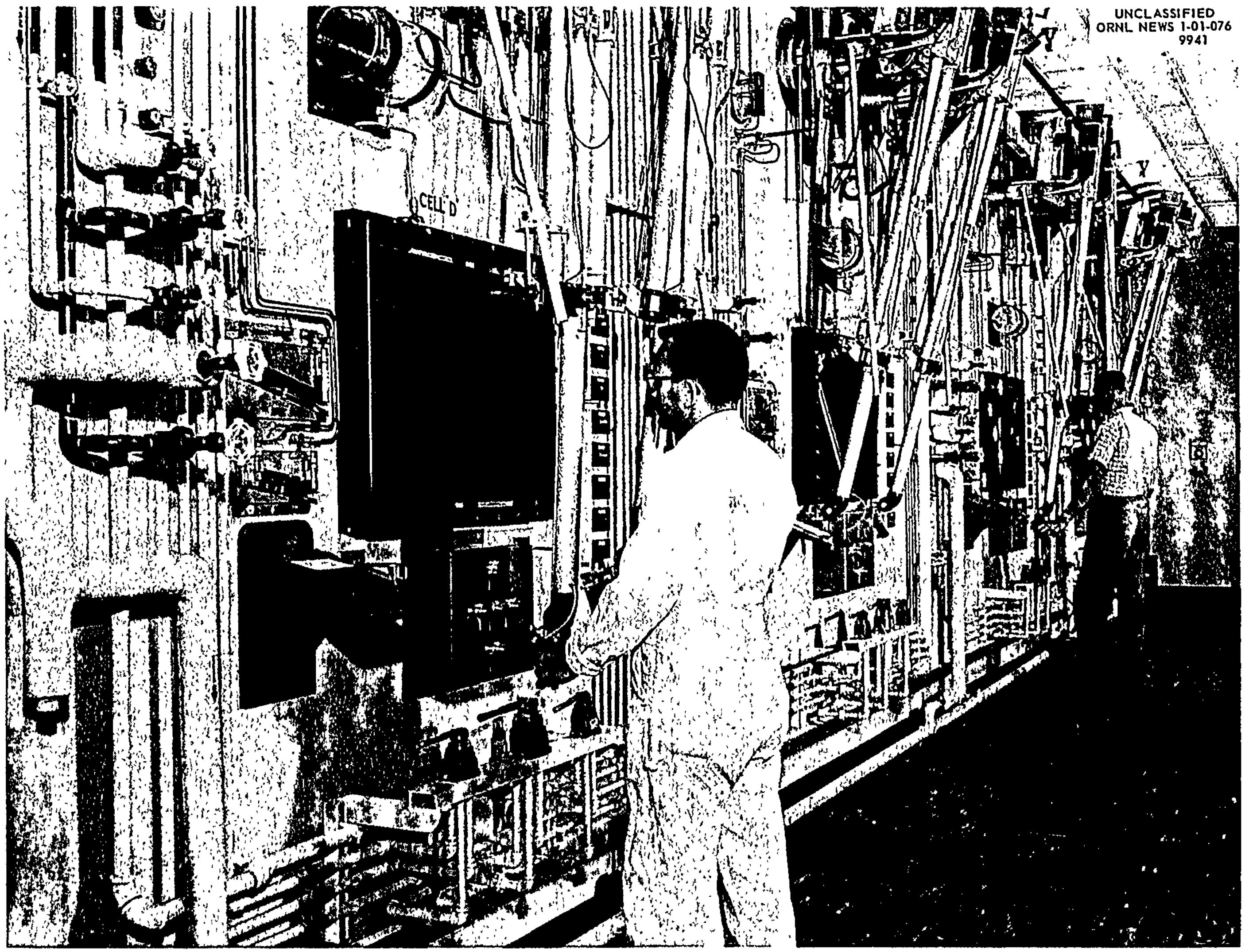

Fig. 7. Radioisotope Development Laboratory Remote Controls for high level cells capable of handling large quantities of gamma, beta, and alpha emitting materials.

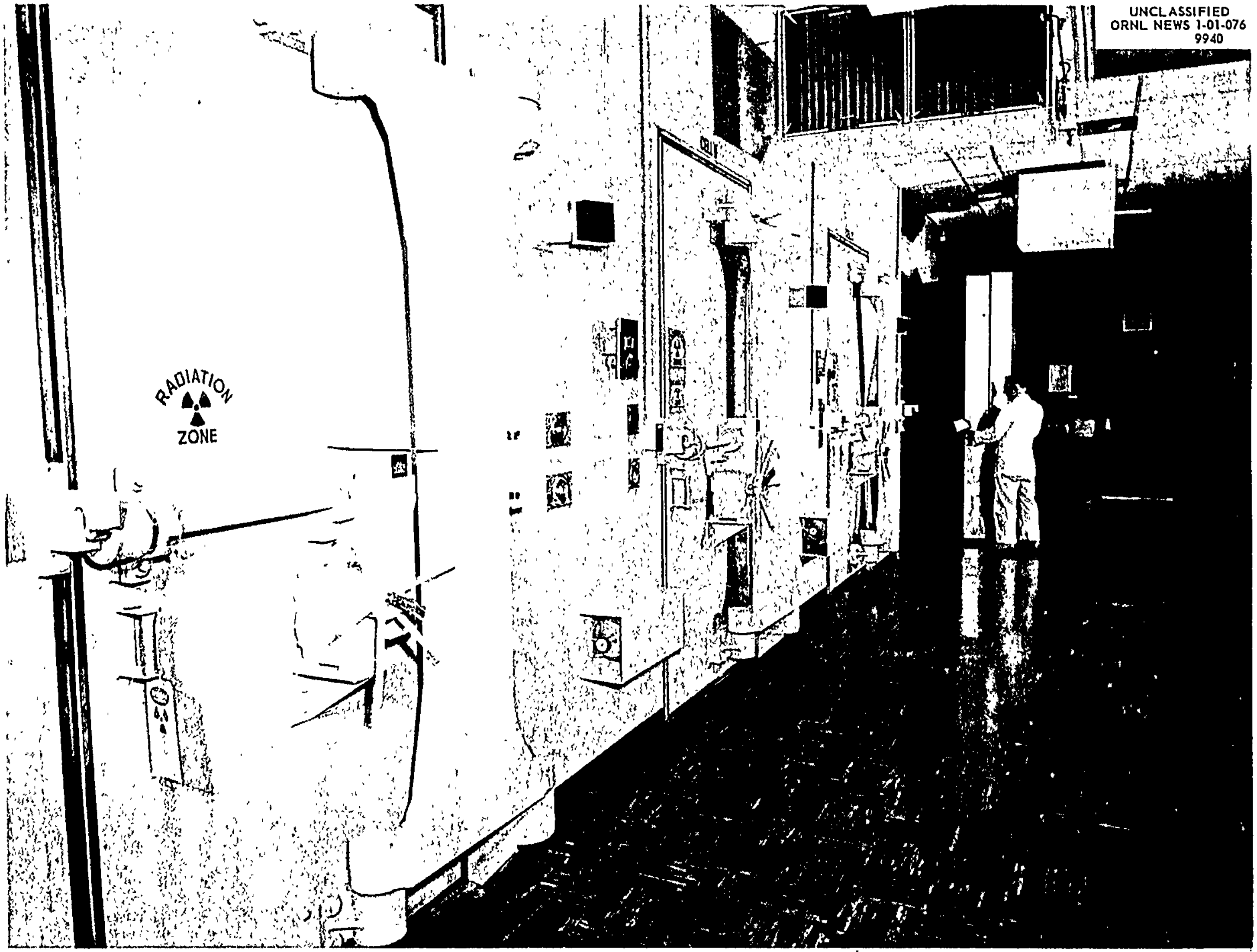

Fig. 8. Radioisotope Development Laboratory. Rear of cells shown in Fig. 7. Heavy doors have hermetic seals.

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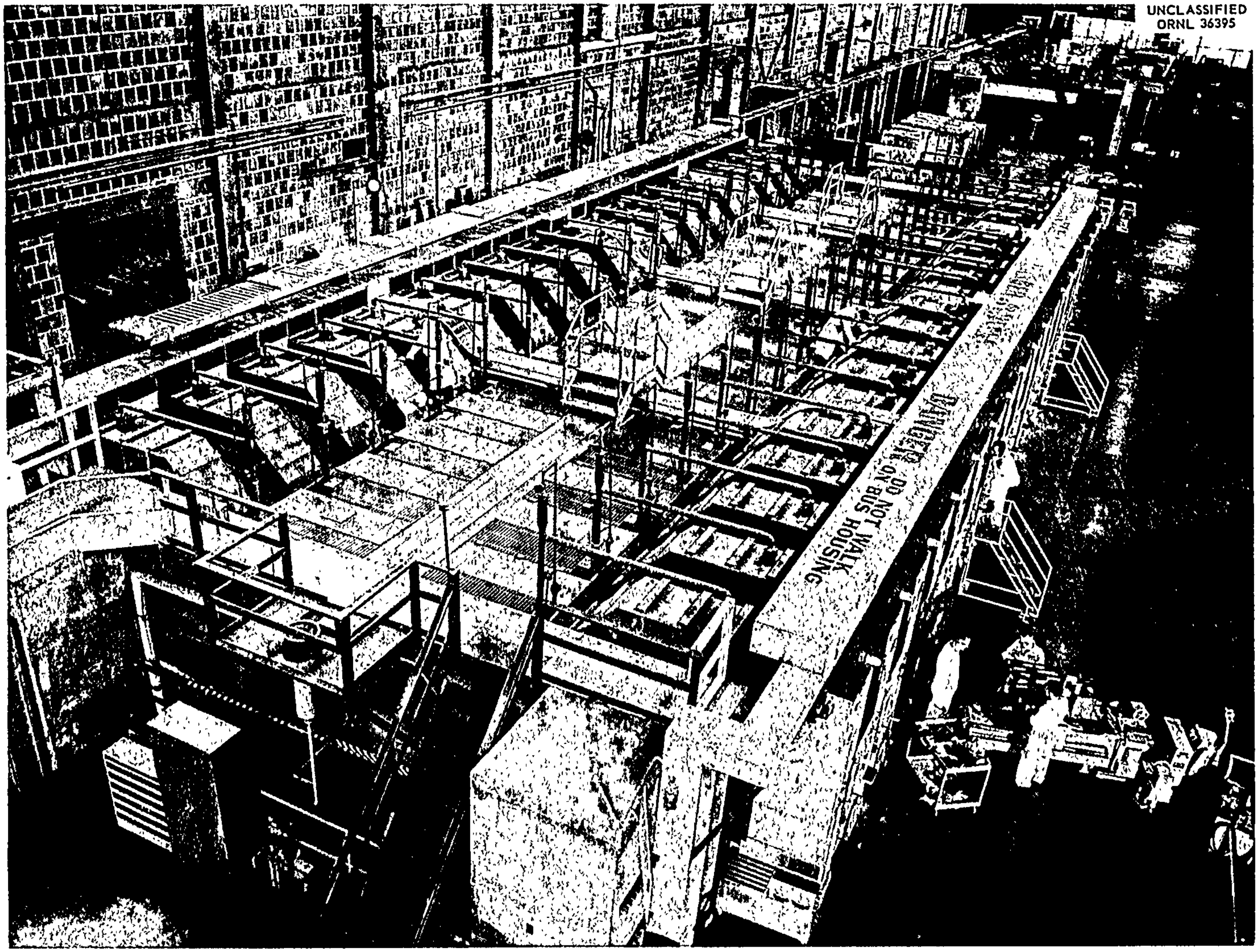

Fig. 9. Electromagnetic Separators (Calutrons) (Y-12 Area) for separating isotopes. Kilogram quantities of stable isotopes are separated in these machines. There is no other installation comparable to this in the Western World.

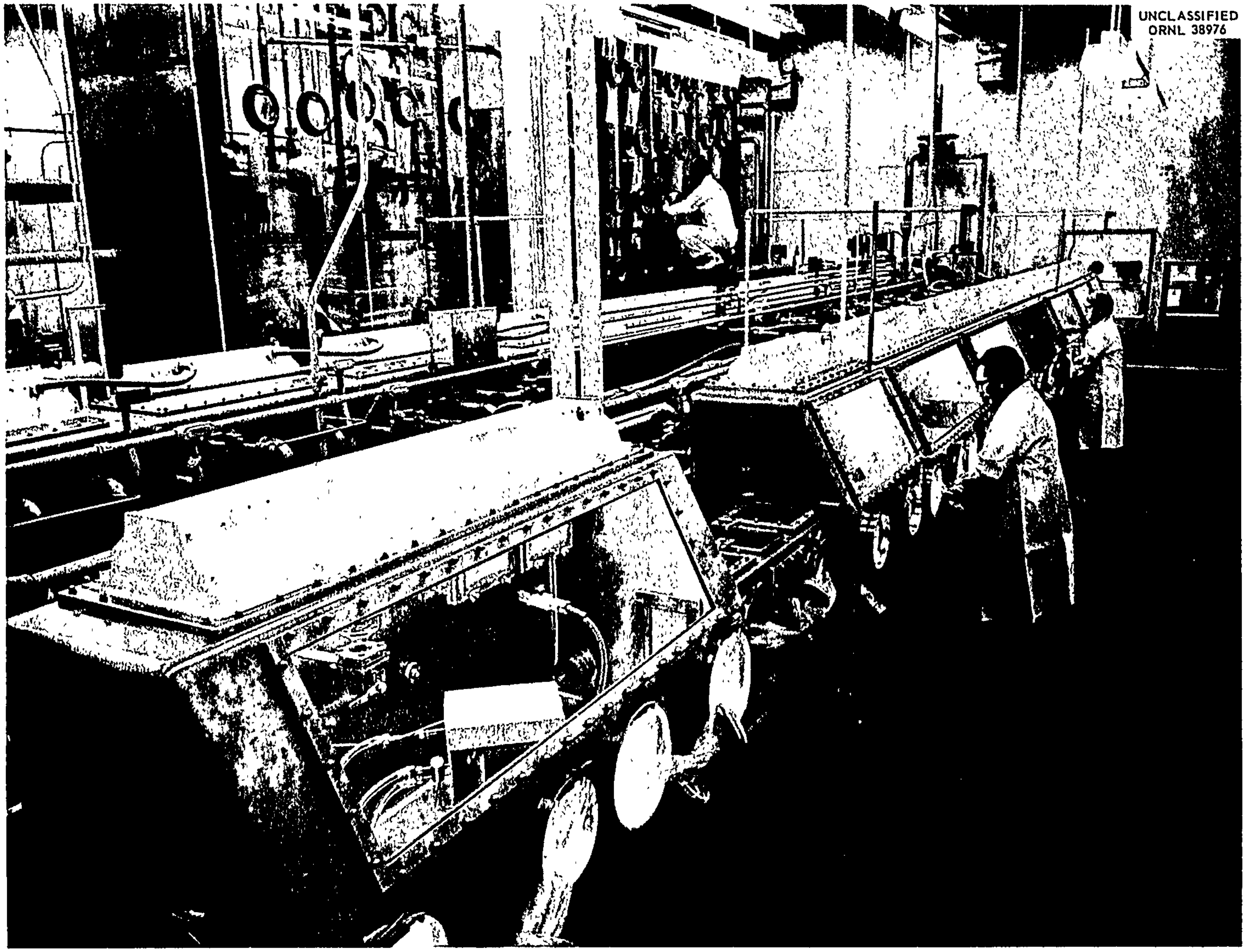

Fig. 10. Laboratory for handling highly enriched isotopes of plutonium, separated on the electromagnetic machines (Calutrons).

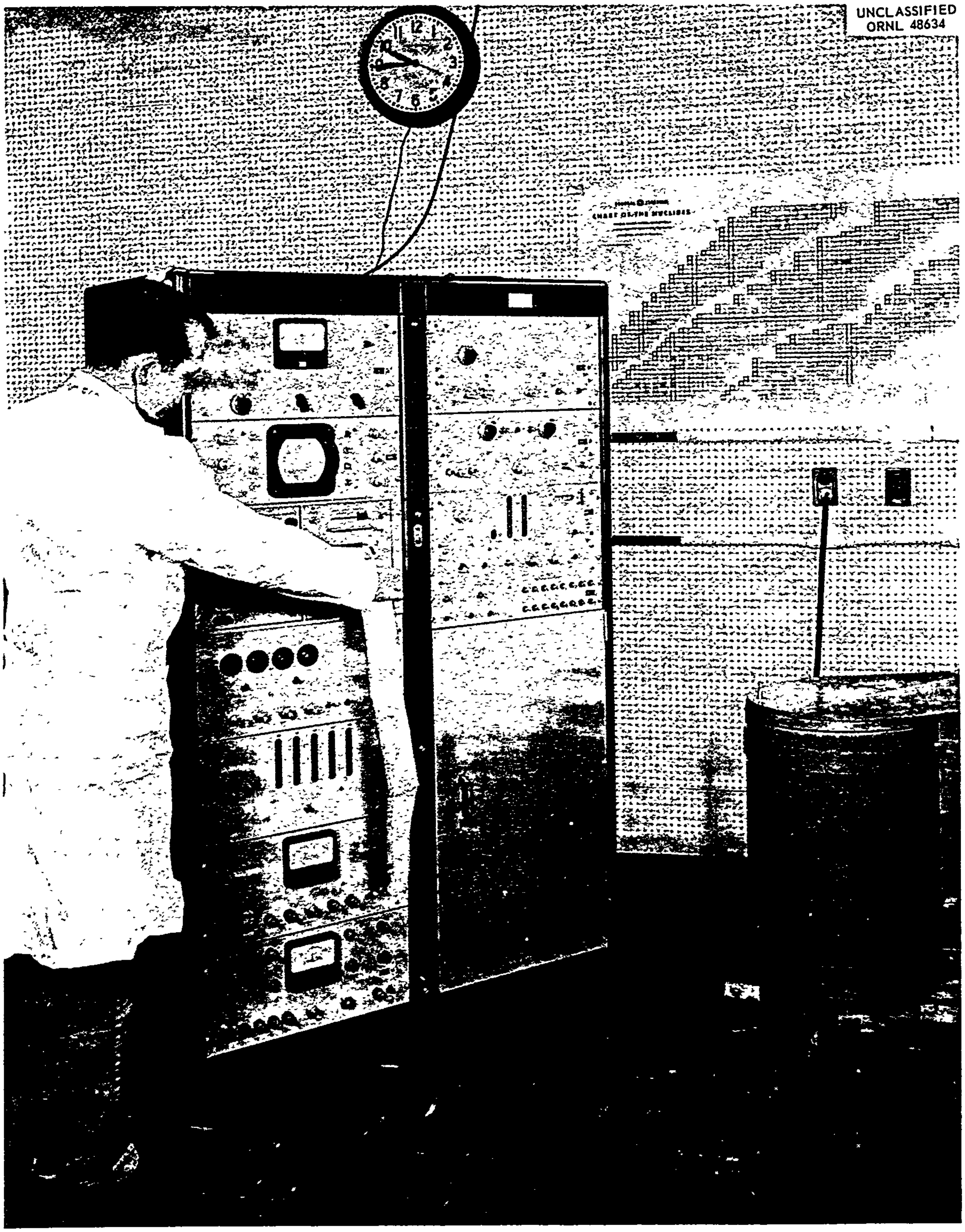

Fig. 11. A Multichannel Analyzer for gamma scintillation spectrometer. This view shows one of the several instruments of this type used in the radiochemistry and radioactivation analysis programs.

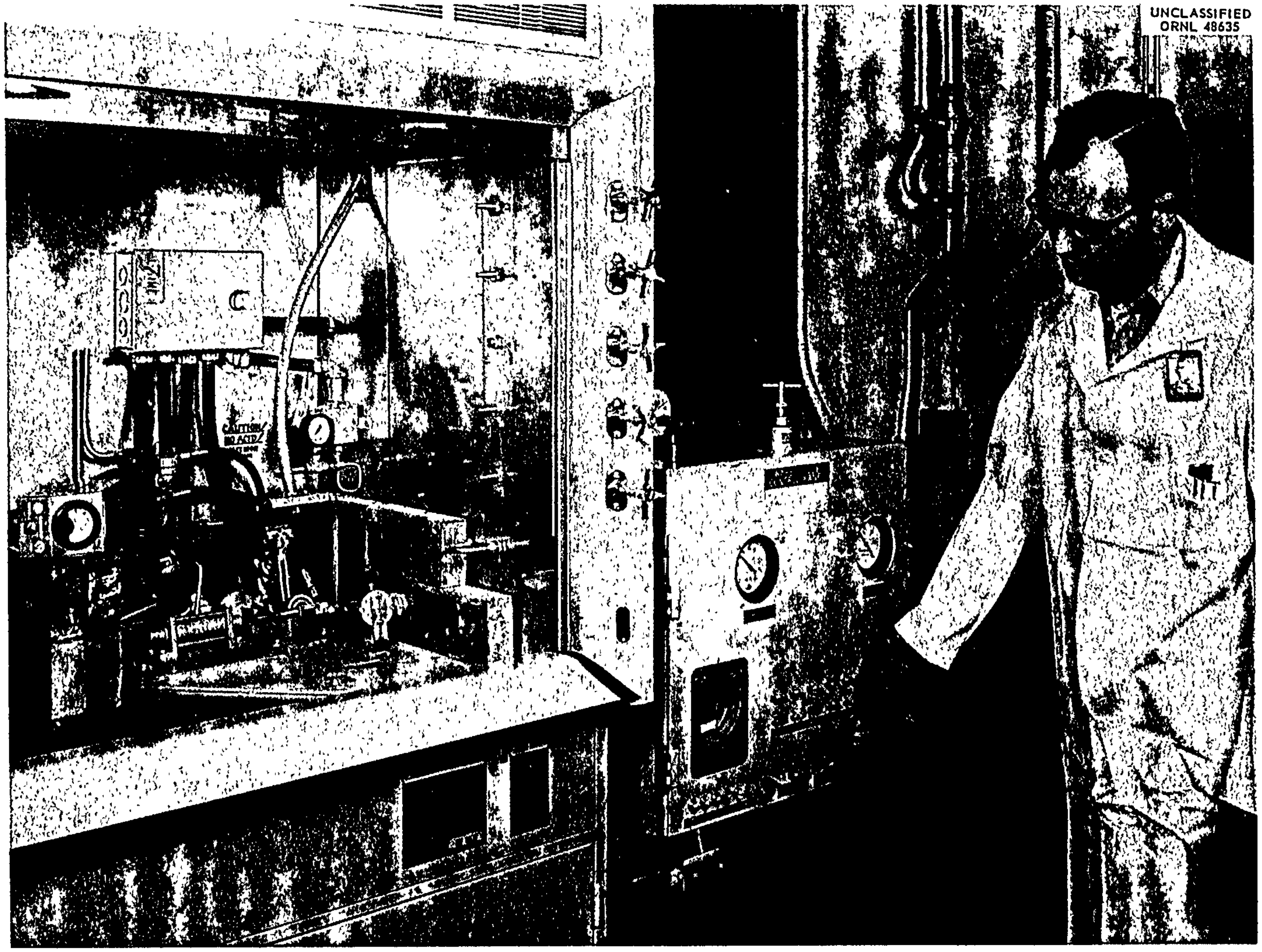

Fig. 12. The "RABBIT" Tube used to irradiate samples in the Oak Ridge Research Reactor for the radioactivation analysis program. It requires about 2 seconds to return the irradiation container to this point after the reactor irradiation. Sample materials containing only about 10^{12} atoms of a trace element are being analyzed through the use of this reactor facility.